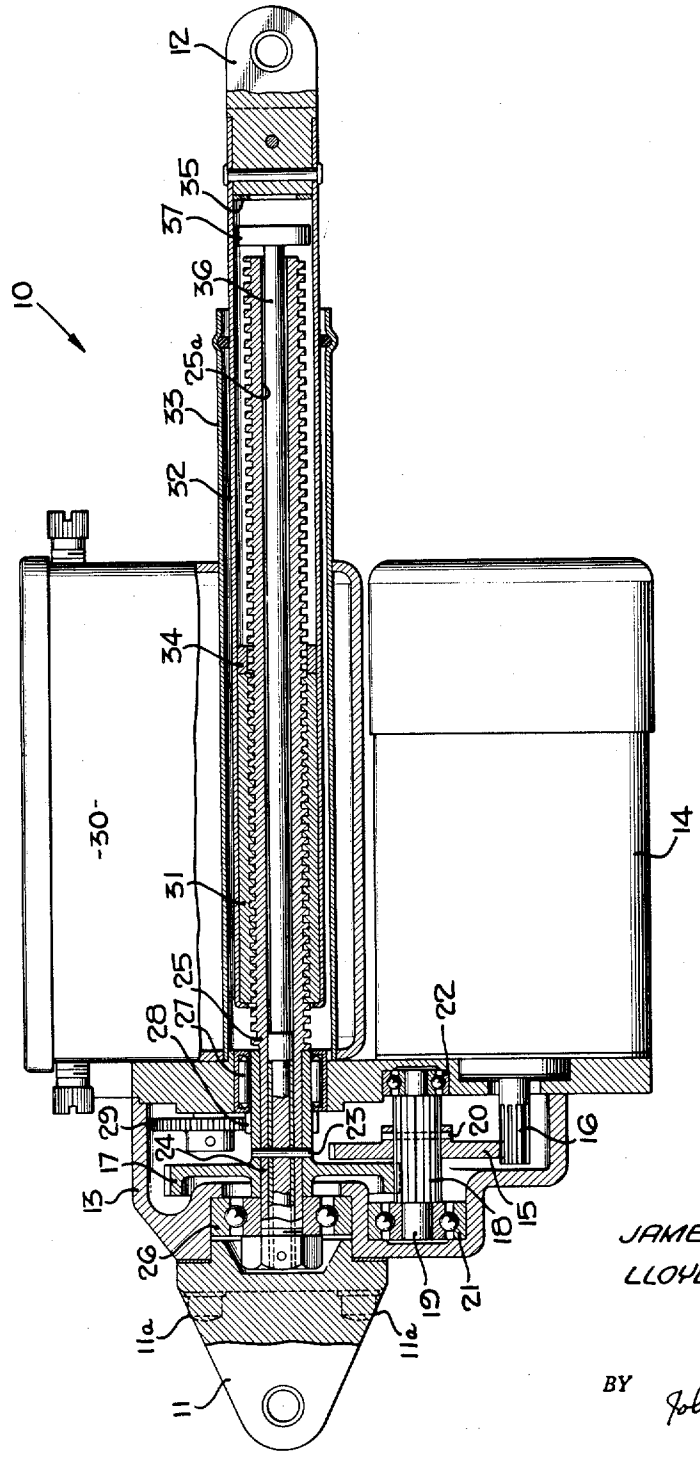
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NON-JAMMING STOP FOR LINEAR ACTUATORS

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# NON-JAMMING STOP FOR LINEAR ACTUATORS

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12 Claims. (Cl. 74—424.8)

**Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.**

This invention pertains to extensible struts, and relates particularly to a means for reducing or eliminating a jam which may occur at either of the extreme limits of movement of such a strut.

Extensible struts of the electrically actuated type are extensively used in aircraft, for example, for the remote control of movable airfoil surfaces. In some applications of such linear actuators it has been found that binding or galling of the translatory member with respect to the stationary member occurs at either or both of the fully retracted and extended positions. As a consequence of such a jam, it is not unusual that the motor upon reversal is incapable of both reducing the jam and accelerating the load. The condition is aggravated by virtue of the fact that such a binding or galling jam occurs at surfaces which move relative to each other in both rotary and longitudinal movements. Hence when the members of the strut are extended or retracted to an extreme limit of movement a quantity of kinetic energy is dissipated as heat because of the jam at the surfaces of the moving parts.

It is an object of this invention to provide means for converting at least a part of the kinetic energy of a jam into potential energy available to assist in unjamming the parts. It is a further object to provide a novel stress member associated with one of the jamming members, wherein the greater portion of the jam kinetic energy is converted to and stored as the potential energy of a stress induced in the member in the form of torsional and/or longitudinal stress, the latter stress being either compressional or tensional.

Further objects will be apparent upon consideration of the preferred embodiment of the invention shown on the drawing and described in detail herein. Since many changes could be made in the preferred embodiment without departing from the scope of the invention, it is intended that all matter contained in the description and shown in the accompanying drawing shall be interpreted as being illustrative rather than as being restrictive of the scope of the invention.

The single figure of the drawing is a partially sectioned view of an extensible strut of the electrically actuated type.

The strut, generally indicated at **10**, is adapted for pivotal mounting to members (not shown) for inducing relative movement therebetween by means of eye fittings **11** and **12**, which are prevented from rotation about the axis of the strut by virtue or their attachment to the aforementioned movable members. Fitting **11** is secured by means of screws **11a** to a gear housing **13**, within which a train of gears is disposed for transmitting power from



an electric or other type of motor **14** to the relatively movable primary parts of the strut to be described. As shown, the gear train comprises a spur gear **15** driven by the pinion shaft **16** of motor **14**, and a spur gear **17** driven by the pinion portion **18** of a countershaft **19** to which the gear **15** is secured, as by splining engagement therewith and by a pin **20**. The countershaft **19** is rotatably contained within the housing **13** by means of anti-friction bearings **21** and **22**.

The spur gear **17** is secured by means of a pin **23** to the reduced portion **24** of a jack screw shaft **25** which comprises one of the two relatively movable primary parts of the strut aforementioned. Anti-friction bearings **26** and **27** support the jackscrew shaft **25** for rotation within the housing **13** on either side of the spur gear **17**. Between the gear **17** and bearing **27** a pinion gear **28** is secured to the shaft **25** and adapted to engage a gear **29** which may actuate an electric switching mechanism in the control box **30**, the latter forming no part of the invention and hence not being described herein. Distal of the bearing **27** the shaft **25** is threaded to receive a cooperating nut **31** for translational movement thereof when the shaft is rotated, the nut **31** constituting the second of the aforementioned relatively movable primary parts of the strut. A thrust sleeve **32**, to the outer end of which the eye fitting **12** is secured, is attached at its inner end to the nut **31** by any preferred means, such as dimpling or brazing. Secured to the housing **13**, and overlying the thrust sleeve **32** is a dust tube **33** within which the sleeve **32** is adapted to move axially.

Attached to the end of nut **31** in any convenient manner is a stress collar **34**, preferably of steel, whose purpose will be hereinafter described. A stress washer **35**, likewise preferably fabricated of steel, may be brazed or otherwise affixed to the inner end of fitting **12** if desired.

The jackscrew shaft **25** has an axial bore **25a** throughout its length and has therewithin a stress rod member **36**, of a slightly smaller diameter than the shaft bore, and anchored therewithin at its leftward end by suitable means, such as brazing. An enlarged head **37** on the rightward end of the member **36** is of slightly smaller diameter than the inside diameter of the thrust sleeve **32**, whereby it is adapted to contact the stress collar **34** when the strut is in extended position and to contact the stress washer **35** when the strut is retracted.

It is now apparent that extension of the strut to its extreme limit causes the nut **31** to traverse the threads of shaft **25** until the collar **34** contacts the enlarged portion **37** of the member **36**, at which time a tendency towards further strut extension will result in (a) tension stress in member **36** by virtue of the linear motion of the nut **31** with respect to shaft **25** and (b) torsion stress in member **36** by virtue of rotary motion of the shaft **25** (and thus of the member **36** and its enlarged head **37**) with respect to nut **31**.

Likewise it is apparent that retraction of the strut to its other extreme limit causes the nut **31** to traverse the threads of shaft **25** until the washer **35** contacts the opposite face of the enlarged head **37** of the member **36**, at which time a tendency toward further strut retraction will result in (a) compression stress, and (b) torsion stress, in member **36**.

In either event, the moving parts come to rest in non-

am association, since the kinetic energy of the usual jam s now stored as potential energy in the resilience of the stress rod member **36** and is employed to augment the starting torque applied by the motor when reverse movement is to be effected:

We claim:

1. A non-jamming stop for members movable rotatively and translationally of each other to one limit of movement thereof, comprising: a first stress member secured to one of said movable members; a second stress member secured to the other of said movable members; friction surfaces on said stress members, at least one of said stress members being adapted to convert at least a portion of the kinetic energy of a jam to the potential energy of a longitudinal and torsional stress in one of said stress members upon frictional engagement of said surfaces; and means for imparting rotative movement to one of said movable members.

[2. The invention of claim 1 further characterized in that the potential energy-storing stress member is secured to the rotative one of said movable members.]

3. A non-jamming stop for members movable rotatively and translationally of each other between limits of movement thereof, comprising: a first stress member secured to one of said movable members; a second stress member secured to the other one of said movable members; a third stress member likewise secured to the said other one of said movable members; friction surfaces on said stress members, said second and third stress members being secured in such manner that said second stress member frictionally engages said first stress member by means of said friction surfaces adjacent one limit of movement of said movable members, and said third stress member frictionally engages said first stress member by means of said friction surfaces adjacent the other limit of movement of said movable members whereby at least one of said stress members converts at least a portion of the kinetic energy of a jam to the potential energy of a longitudinal and torsional stress in one of said stress members uon frictional engagement; and means for imparting rotative movement to one of said movable members.

[4. The invention of claim 3 further characterized in that said first stress member is the potential energy storing member.]

[5. The invention of claim 4 further characterized in that said first stress member is secured to the rotative one of said movable members.]

6. An extensible strut for the movement of one part relative to another part to one limit of movement therebetween, comprising: a housing; means connecting said housing with one of said parts; a first movable member in said housing; a second movable member in threaded screw relation to said first movable member; means connecting said second movable member with the other of said parts; means associated with one of said movable members for imparting rotative movement thereto; a first stress member secured to one of said movable members; a second stress member secured to the other of said movable members; and friction surfaces on said stress members, at least one of said stress members being adapted to convert at least a portion of the kinetic energy of a jam to the potential energy of a longitudinal and a torsional stress in one of said stress members upon frictional engagement of said surfaces.

[7. The invention of claim 6 further characterized in that the potential energy storing stress member is secured to the rotative one of said movable members.]

8. An extensible strut for the movement of one part relative to another part between limits of movement thereof, comprising: a housing; means connecting said housing with one of said parts; a first movable member in said housing; a second movable member in threaded screw relation to said first movable member; means connecting said second movable member with the other of said parts; means associated with one of said movable members for



imparting rotative movement thereto; a first stress member secured to one of said movable members; a second stress member secured to the other one of said movable members; a third stress member likewise secured to said other one of said movable members; and friction surfaces on said stress members, said second and third stress members being secured in such manner that said second stress member frictionally engages said first stress member by means of said friction surfaces at one limit of movement of said movable members, and said third stress member frictionally engages said first stress member by means of said friction surfaces at the other limit of movement of said movable members whereby at least one of said stress members converts at least a portion of the kinetic energy of a jam to the potential energy of a longitudinal and torsional stress in said one of said stress members upon frictional engagement of said surfaces.

[9. The invention of claim 8 further characterized in that said first stress member is the potential energy storing member.]

[10. The invention of claim 9 further characterized in that said first stress member is secured to the rotative one of said movable members.]

[11. An actuator comprising members movable relative to each other to a limit of movement, a torsion stress member connected with one of said members and having a surface frictionally engaging a surface on the other of said members at the region of said limit of movement, said stress member being torsionally stressed after engagement of said surfaces at said limit of movement.]

[12. A gearing comprising screw and nut members movable relative to one another, said members having portions limiting said relative movement, one of said portions comprising a torsion stress means having a friction surface, the other of said portions also including a friction surface arranged to slidably engage the first friction surface at the limit of movement of the nut member relative to the screw member, said stress means becoming stressed after said surfaces are engaged.]

*13. An actuator comprising:*

*(a) members movable rotatively relative to each other to a limit of movement;*

*(b) a substantially straight rodlike torsion stress member connected with one of said members and having a surface frictionally engaging a surface on the other of said members at the region of said limit of movement, said stress member being torsionally stressed after relatively rotative engagement of said surfaces at said limit of movement.*

*14. A gearing comprising:*

*(a) screw and nut members movable rotatively relative to one another, said members having portions limiting said relative movement, one of said portions comprising a substantially straight rodlike torsion stress means having a friction surface;*

*(b) the other of said portions also including a friction surface arranged to slidably engage the first friction surface at the limit of movement of the nut member relative to the screw member, said stress means becoming torsionally stressed after said surfaces are rotatively engaged.*

*15. A non-jamming linear actuator comprising:*

*(a) a screw member;*

*(b) a nut member in threaded engagement with said screw member;*

*(c) means for rotating one of said members to move both of said members rotatively and translationally relative to each other to one limit of movement;*

*(d) a substantially straight elongated torsion stress member having one end secured to one of said members and having a friction face on its opposite end; and*

*(e) a friction face on the other one of said members adapted to slidably engage said friction face on said*

torsion stress member upon movement of said members to said limit;

(f) whereby after engagement of said friction faces said torsion stress member is stressed both longitudinally and torsionally to convert at least a portion of the kinetic energy of a jam to the potential energy of a longitudinal and torsional stress.

16. A non-jamming linear actuator particularly adapted for airborne use, comprising:

(a) a screw member;

(b) a nut member in threaded engagement with said screw member;

(c) means for rotating one of said members to move both of said members rotatively and translationally relative to each other to one limit of movement;

(d) a torsion stress rod having one end secured to one of said members and having an enlarged head on its opposite end;

(e) said enlarged head of said stress rod having a friction face; and

(f) a friction face on the other one of said members adapted to slidably engage said friction face on said enlarged head upon movement of said members to said limit;

(g) whereby after engagement of said friction faces said stress rod is stressed both longitudinally and torsionally to convert at least a portion of the kinetic energy of a jam to the potential energy of a longitudinal and torsional stress.

17. A non-jamming linear actuator comprising:

(a) a hollow screw member forming an elongated interior chamber;

(b) a nut member in threaded engagement with said screw member;

(c) means for rotating one of said members to move both of said members rotatively and translationally relative to each other to one limit of movement;

(d) a torsion stress rod disposed in said interior chamber and having one end secured to said screw member and having an enlarged head on its opposite end extending beyond said screw member;

(e) said enlarged head of said stress rod having a friction face; and

(f) a friction face on said nut member adapted to slidably and frictionally engage said friction face on said enlarged head upon movement of said members to said limit;

(g) whereby after engagement of said friction faces said stress rod is stressed both longitudinally and torsionally to convert at least a portion of the kinetic energy of a jam to the potential energy of a longitudinal and torsional stress.

18. A non-jamming linear actuator comprising:

(a) a screw member;

(b) a nut member in threaded engagement with said screw member;

(c) electric power means for selectively rotating one of said members in opposite directions to move both of said members rotatively and translationally of each other between two limits of movement thereof;

(d) a substantially straight rod-shaped stress member having one end secured to one of said members and having an enlarged head on its opposite end;

(e) said enlarged head having friction faces on opposite sides thereof; and

(f) two spaced friction faces on the other one of said members, each face being adapted to slidably and frictionally engage one of the friction faces of said enlarged head upon movement of said members to one or the other limit thereof while being rotated by said power means;

(g) whereby said stress member converts at least a portion of the kinetic energy of a jam created by the engagement of a pair of cooperating friction faces due to the movement of said members to one of said



limits by said power means to the potential energ of a longitudinal and torsional stress upon said sli able frictional engagement between each pair of c operating friction faces.

19. A non-jamming linear actuator comprising:

(a) a screw member;

(b) a nut member in threaded engagement with sai screw member;

(c) means for selectively rotating one of said membe in opposite directions to move both of said membe rotatively and translationally of each other betwee two limits of movement thereof;

(d) a stress rod having one end secured to said scre member and having an enlarged head on its opp site end extending beyond said screw member;

(e) said enlarged head having friction faces on opp site sides thereof; and

(f) two spaced friction faces on said nut membe each being adapted to slidably and frictionally e gage one of the friction faces of said enlarged hea upon movement of said members to one or the oth limit thereof;

(g) whereby said stress rod converts at least a portio of the kinetic energy of a jam to the potential energ of a longitudinal and torsional stress upon said sli able frictional engagement between each pair of c operating friction faces.

20. A non-jamming linear actuator particularly adapte for airborne use comprising:

(a) a screw member, said screw member being hollo to provide a hollow chamber;

(b) a nut member in threaded engagement with sa screw member;

(c) electric power means for selectively rotating sa screw member in opposite directions to move bo of said members rotatively and translationally each other between two limits of movement thereo

(d) a stress rod disposed in said hollow chamber said screw member and having one end secured said screw member and having an enlarged head its opposite end extending beyond said screw me ber;

(e) said enlarged head having friction faces on opp site sides thereof;

(f) two spaced friction faces on said nut member, ea being adapted to slidably and frictionally engage o of the friction faces of said enlarged head up movement of said members to one or the other lim thereof caused by the rotation of said screw memb by said power means to create a jam;

(g) whereby said stress rod converts at least a portic of the kinetic energy of said jam to the potenti energy of a longitudinal and torsional stress up said slidable frictional engagement between ea pair of cooperating friction faces.


**References Cited by the Examiner**

The following references, cited by the examiner, are record in the patented file of this patent or the origin patent

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 514,307 | 2/94 | Crapp | 248—4 |
| 1,824,679 | 9/31 | Morris | 268— |
| 1,906,365 | 5/33 | Burkholder | 254—1 |
| 2,182,584 | 12/39 | Fitz Gerald | 74— |
| 2,187,152 | 1/40 | Gwinn | 244— |
| 2,319,463 | 5/43 | Lear | 123—41— |
| 2,349,332 | 5/44 | Angell | 74—424 |
| 2,398,841 | 4/46 | Morris | 74—424 |
| 2,407,537 | 9/46 | Chapman | 192—1 |
| 2,410,695 | 11/46 | Werner | 192—1 |
| 2,417,434 | 3/47 | Mead et al. | 192—1 |


**(Other references on following page)**

7

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 2,422,905 | 6/47 | Jackson | 192—142 |
| 2,424,492 | 7/47 | Morris | 74—424.8 |
| 2,441,505 | 5/48 | Ochtman | 192—142 |
| 2,460,222 | 1/49 | Hall | 74—424.8 |
| 2,465,601 | 3/49 | Ochtman | 192—.02 |
| 2,479,019 | 8/49 | Ochtman | 74—424.8 |
| 2,482,568 | 9/49 | Werner | 74—785 |
| 2,500,691 | 3/50 | Lear | 74—424.8 |

8

| | | | |
|---|---|---|---|
| 2,590,251 | 3/52 | Hoover | 74—428.8 |
| 2,660,281 | 11/53 | Ochtman | 192—141 |

OTHER REFERENCES

Mechanical Engineers Handbook, Lionel S. Marks, 4th edition, 1941, page 2186, Figure 68.

Mechanical Engineers Handbook, William Kent, 10th edition, 1923, page 370.


DON A. WAITE, *Primary Examiner.*